WAS THERE A "CORDILLERAN GLACIER" IN BRITISH COLUMBIA?

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In August, 1888, the late Dr. G. M. Dawson, then assistant director of the Geological Survey of Canada, published in the *Geological Magazine* a paper entitled "Recent Observations on the Glaciation of British Columbia and Adjacent Regions," in which he states that

the examination of this northern region may now be considered to have established that the main gathering-ground or *névé* of the great Cordilleran Glacier of the west coast, was included between the fifty-fifth and fifty-ninth parallels of latitude in a region which, so far as explored, has proved to be of an exceptionally mountainous character. It would further appear that this great glacier extended, between the Coast Range and the Rocky Mountains, southeastward nearly to latitude 48°, and northwestward to latitude 63°, or beyond, while sending also smaller streams to the Pacific Coast.

In a subsequent paper[1] published in the *American Geologist* for September, 1890, he writes of his conclusions derived from his geological explorations in British Columbia as follows:

Having thus surrounded the area of this great glacier, it was proposed to name it the *Cordilleran Glacier* in order to distinguish it from the second and larger ice-cap by which the northeastern part of the continent was at the same period more or less completely covered.

The Cordilleran Glacier, as thus defined, had, when at its maximum development, a length of nearly 1,200 miles. The main gathering-ground or *névé* of the *mer de glace* was contained approximately between the fifty-fifth and fifty-ninth parallels of north latitude, that part of the ice which flowed northwestward having a length beyond these limits of 350 miles, that which flowed in the opposite direction a length of about 600 miles.

In another place in the same paper he says:

The width of this (Cordilleran) zone is about 400 miles, and on one side of it lies the wide area of the Great Plains, on the other the Pacific

[1] "On the Glaciation of the Northern Part of the Cordillera," by George M. Dawson, *Am. Geol.*, September, 1890, pp. 153–62.

Ocean. . . . . This part of the Cordillera of the West was, in the Glacial period, covered by a great confluent glacier-mass.

In a longer paper, published in the same year in the *Transactions of the Royal Society of Canada* (Vol. 8, Sec. 4, pp. 3–74), he reiterated his belief in this glacier, and gave a map showing its extent from the Yukon Territory down to an irregular line south of latitude 49°.

Last summer my mining duties called me to British Columbia and I traveled by the Grand Trunk Pacific Railway, stopping off at Prince George, which is on the interior plateau of the province, just south of latitude 54° north, and 80 or 90 miles in a direct line southwest of the eastern range of the Rocky Mountains. Its elevation is 1,862 feet above sea-level. From Prince George I descended the Fraser River, a distance of about 70 miles in a straight line, to Quesnel, which lies at an elevation of 1,570 feet above sea-level, and from there went eastward 50 miles to the old gold-mining district of Cariboo, which is at an elevation of about 4,000 feet above sea-level. During this time I was in the middle of the region of which Dr. Dawson writes "that the ice reached a general thickness of 2,000 to 3,000 feet above even the higher tracts of the plateau, while it must have attained a thickness of over 6,000 feet above the main river valleys and other principal depressions of the surface."[1] It was therefore natural for me to look for evidence of intense ice action such as may be seen in valleys cutting through or descending from the Coast Range of this western province, but such evidence was conspicuously absent.

The Fraser River flows in a direction a little east of south in the bottom of a great wide valley, with high rugged mountains in the distance both to the east and west, this valley being simply the lowest part of the great interior plateau of British Columbia.

On the eastern side of this valley or plateau, and on the western slopes of the mountains which define its eastern rim, is the Cariboo district in which marvelously rich placer mines were discovered and worked in the early sixties of last century. The rocks composing the mountains are pre-Cambrian or Cambrian sericitic and chloritic schists. Deep, narrow valleys carry streams

[1] *Am. Geol.*, September, 1890, p. 155.

down from the sides of these mountains, and gold was found in gravel, and in bedrock beneath the gravel, in the bottom of these valleys. Much of the gold occurred in preglacial, or Pliocene, gravels that had been buried under a bed of massive bowlder clay, holding many glaciated pebbles and bowlders. Immediately under the bowlder clay is often a stratified deposit of fine quicksand or slimy silt, locally known as "slum," which is a sericitic silt that was washed from the decomposed surface of the rock by glacial streams before the advancing glaciers themselves had reached so far down the valleys.

It was in the latter part of the month of May, and snow still covered the tops of the ridges when I was in the district. Though I saw many rock exposures, but one, a quartz vein, had preserved glacial grooves and striae. This vein was on the north side of the valley of Lightning Creek, one of the principal streams of the district, and 1,000 feet above the bottom of the valley, or 4,800 feet above the sea. The markings ran N. 45° W. (true), which was roughly parallel to the course of the valley, and the direction of motion of the ice was quite clearly indicated by some rock cliffs in the vicinity.

As Lightning Creek Glacier moved down the valley it removed loose material from the lateral slopes and deposited some of it in the tributary gulches, thus covering the bottoms and the upper sides of these gulches. After the glacier had retired and disappeared, the drainage of the country was re-established in the same gulches as before, but on top of the bowlder clay left by the glacier and farther down the stream, so that when the gold miners wanted to find the deeper preglacial channels of the gulches they were obliged to explore for them in an easterly direction or up the main stream. In the valleys of Slough Creek and Willow River similar conditions prevail with regard to the lateral gulches, as doubtless local valley glaciers also moved westward and northwestward down these valleys.

Well-marked moraines are present in many of the valleys, conspicuous among them being a large hilly moraine in the valley of Slough Creek below Jack-of-Clubs Lake, and a similar lumpy, pitted moraine in Lightning Creek Valley below Stanley.

Hydraulic operations have exposed excellent sections of bowlder clay in a number of places, and there is only one bowlder clay, namely that of the valley glaciers. I am quite satisfied that the only glaciation that has ever prevailed in this country was the local glaciation from the adjoining mountains.

After spending a few days in the district we returned westward along the wagon road to Quesnel. This road follows the bottom of the valley of Lightning Creek Valley for 15 miles or more, then crosses a sand and gravel plain, after which it descends into the valley of Cottonwood River. In this distance very little rock is exposed, and there is but little evidence of glaciation, except one or two local moraines. On Cottonwood River, near the bridge, basic igneous rocks occur, probably cutting the Oligocene conglomerates, but I was unable to find any evidence of glaciation on them.

Five or six miles farther west the road crosses a lumpy moraine dotted with small lakes, and a short distance farther west it skirts a low rounded hill of porphyritic red granite, the surface of which shows strong glacial markings running N. 15° W., the direction being clearly indicated by the rounded stoss and broken lee sides of the knolls. As seen from this hill the view to the southward is up the wide valley of the Quesnel River, and it is evident that the glacier which formed the markings on the rock descended this valley. The moraine just crossed was also doubtless formed by the same glacier. Though a careful examination was made of the exposed rock no scoring or polishing, other than that caused by the one glacier, could be found. From this rocky hill, which is at an elevation of 3,200 feet above the sea, our course was westward for about 14 miles to the village of Quesnel on the east bank of Fraser River. Throughout this distance no rock was seen, the surface being mostly composed of sand and gravel arranged in wide terraces, though bowlder clay was occasionally recognized.

Fraser River itself, between Prince George and Quesnel, is a large stream which has cut out a winding, gorgelike valley. Above Quesnel as far as Cottonwood Canyon the banks are steep, often almost vertical, and are composed of horizontally stratified conglomerate and soft sandstones of Miocene(?) age.

As seen from the river the banks rise to a horizontal plain, which extends eastward and westward for an indefinite distance. Here and there as many as five different terraces might be counted one above the other on the insides of some of the bends, but altogether the valley has a very juvenile appearance. It is clearly preglacial, for bowlder clay may be seen resting on its sloping sides and lying on some of its terraces. In some places, where it has been partly filled by bowlder clay during the glacial period, the channel has been re-excavated to about its previous depth. Near the top of its banks beds of bowlder clay are here and there interstratified with layers of sand, some of which have been crumpled, giving evidence that glaciers from the mountains to the east or west descended into lakes which then existed in the bottom of the valley, and squeezed up the beds of gravel and sand that had just been deposited in those lakes.

Above Cottonwood Canyon the valley maintains the same general character as below it, with steep banks rising to the adjoining plain, but in addition to the Miocene(?) conglomerates, etc., schistose rocks, similar to the Cariboo schists, outcrop here and there, while at still other places the banks are composed of stratified sand or clay of glacial or postglacial age.

It is impossible to imagine such a winding, gorgelike valley as this of the Fraser River, with its short curves, and with the relatively sharp angles where its steep sides meet the surrounding plain, continuing to exist after a great continental glacier many thousands of feet in thickness has passed along it. Its appearance is quite different from that of such of the British Columbia valleys as have undoubtedly been occupied by great glaciers. On the contrary it has a strong topographic resemblance to the Yukon Valley near Dawson City, where the river flows through an unglaciated part of the Yukon Plateau, which is a northern continuation of the interior plateau of British Columbia. Here glaciers formerly descended from the Coast Range of mountains eastward to the interior plateau, and others descended from the Rocky Mountain range westward to the same plateau, but as they did not meet they left an unglaciated area between them. In the Fraser Valley glaciers also descended from the mountains to the east

and to the west, toward the middle line of the intermediate plateau or valley. For the most part they ended before they reached the present river channel, but in other cases they discharged into great lakes, in which the white silts which form such conspicuous cliffs near Prince George were deposited.

The glaciers always moved inward from the mountains which form the sides of the valley toward its median line, and the ice was thicker on the mountains than in the valley. At no time was this portion of the interior plateau covered by a glacier of the extent and thickness indicated by Dr. Dawson, namely 6,000 feet deep over the lower land, from which the ice moved outward in all directions.

This conclusion is in accord with the observations of the late G. S. Malloch, of the Geological Survey of Canada, who, in 1909, made a geological examination of the upper part of the Fraser River from Tête Jaune Cache down to Prince George. He states that

> bowlder clay occurs at different points along the river. These deposits were formed by two sets of glaciers, the first of which descended into the Interior Plateau from the mountains to the east, and the second from those to the west. The drift of the latter is characterized by the presence of granite fragments from the Coast Range, and volcanic rocks from the western part of the plateau. On the other hand, that from the east contains fragments of older rocks, and it alone is seen on the river from Tête Jaune Cache to Giscome Rapids, where it is overcapped by the drift from the west.[1]

These observations therefore exclude the possibility of the existence of a great longitudinally moving Cordilleran Glacier on this portion of the interior plateau in latitude 54°, and my own observations show that it was absent as far south as Quesnel in latitude 53°. From there to the southern end of the glacier as defined by Dr. Dawson is only a little more than 300 miles, and even if the whole of the country throughout this distance were covered by ice it would not fulfil the idea of a great continental glacier. As to what were the ice conditions north of Prince George, between latitude 54° and 63°, we have not yet sufficient information available to enable us to decide.

[1] *Geol. Surv. Can. Sum. Rep. for 1909*, Ottawa Govt., 1910, p. 128.